Compared with the landmark-guided approach and ultrasound-guided cannulation

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Problem

- Internal jugular vein catheters placement is a procedure required for the resuscitation of shock patients, heart surgery ...
- There are several methods to perform
- Choose any method to minimize complications and improve safety for patient

History

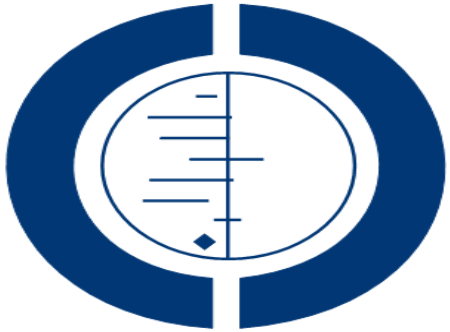
- Be made first in 1984 by Legler and Nugent
- Many studies comparing the effectiveness between methods

Methods of performed

- Catheters according to anatomical landmarks
- Under ultrasonographic marker
- Under ultrasound guidance

Ultrasound guidance versus anatomical landmarks for internal jugular vein catheterization (Review)

Brass P, Hellmich M, Kolodziej L, Schick G, Smith AF



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[Intervention Review]

Ultrasound guidance versus anatomical landmarks for internal jugular vein catheterization

ABSTRACT

Background

Central venous catheters (CVCs) can help with diagnosis and treatment of the critically ill. The catheter may be placed in a large vein in the neck (internal jugular vein), upper chest (subclavian vein) or groin (femoral vein). Whilst this is beneficial overall, inserting the catheter risks arterial puncture and other complications and should be performed with as few attempts as possible. Traditionally, anatomical 'landmarks' on the body surface were used to find the correct place in which to insert catheters, but ultrasound imaging is now available. A Doppler mode is sometimes used to supplement plain 'two-dimensional' ultrasound.

Objectives

The primary objective of this review was to evaluate the effectiveness and safety of two-dimensional (imaging ultrasound (US) or ultrasound Doppler (USD)) guided puncture techniques for insertion of central venous catheters via the internal jugular vein in adults and children. We assessed whether there was a difference in complication rates between traditional landmark-guided and any ultrasound-guided central vein puncture.

Our secondary objectives were to assess whether the effect differs between US and USD; whether the effect differs between ultrasound used throughout the puncture ('direct') and ultrasound used only to identify and mark the vein before the start of the puncture procedure (indirect'); and whether the effect differs between different groups of patients or between different levels of experience among those inserting the catheters.

GRADE Working Group grades of evidence.

High quality: Further research is very unlikely to change our confidence in the estimate of effect.

Moderate quality: Further research is likely to have an important impact on our confidence in the estimate of effect and may change the estimate.

Low quality: Further research is very likely to have an important impact on our confidence in the estimate of effect and is likely to change the estimate.

Very low quality: We are very uncertain about the estimate.

SUMMARY OF FINDINGS FOR THE MAIN COMPARISON *[Explanation]*

Ultrasound guidance compared with anatomical landmarks for internal jugular vein cannulation for central vein catheterization

Patient or population: patients with internal jugular vein cannulation for central vein catheterization
Settings:
Intervention: ultrasound guidance
Comparison: anatomical landmark

Outcomes	Illustrative comparative risks* (95% CI)		Relative effect (95% CI)	Number of participants (studies)	Quality of the evidence (GRADE)	Comments
	Assumed risk	Corresponding risk				
	Anatomical landmark	Ultrasound guidance				
Complication rate total	Study population		RR 0.29 (0.17 to 0.52)	2406 (14 studies)	⊕◯◯◯ Very low[a,b,c,d]	
	135 per 1000	39 per 1000 (23 to 70)				
	Moderate					
	136 per 1000	39 per 1000 (23 to 71)				
Overall success rate	Study population		RR 1.12 (1.08 to 1.17)	4340 (23 studies)	⊕◯◯◯ Very low[c,e,f,g]	
	876 per 1000	982 per 1000 (946 to 1000)				
	Moderate					
	850 per 1000	952 per 1000 (918 to 994)				

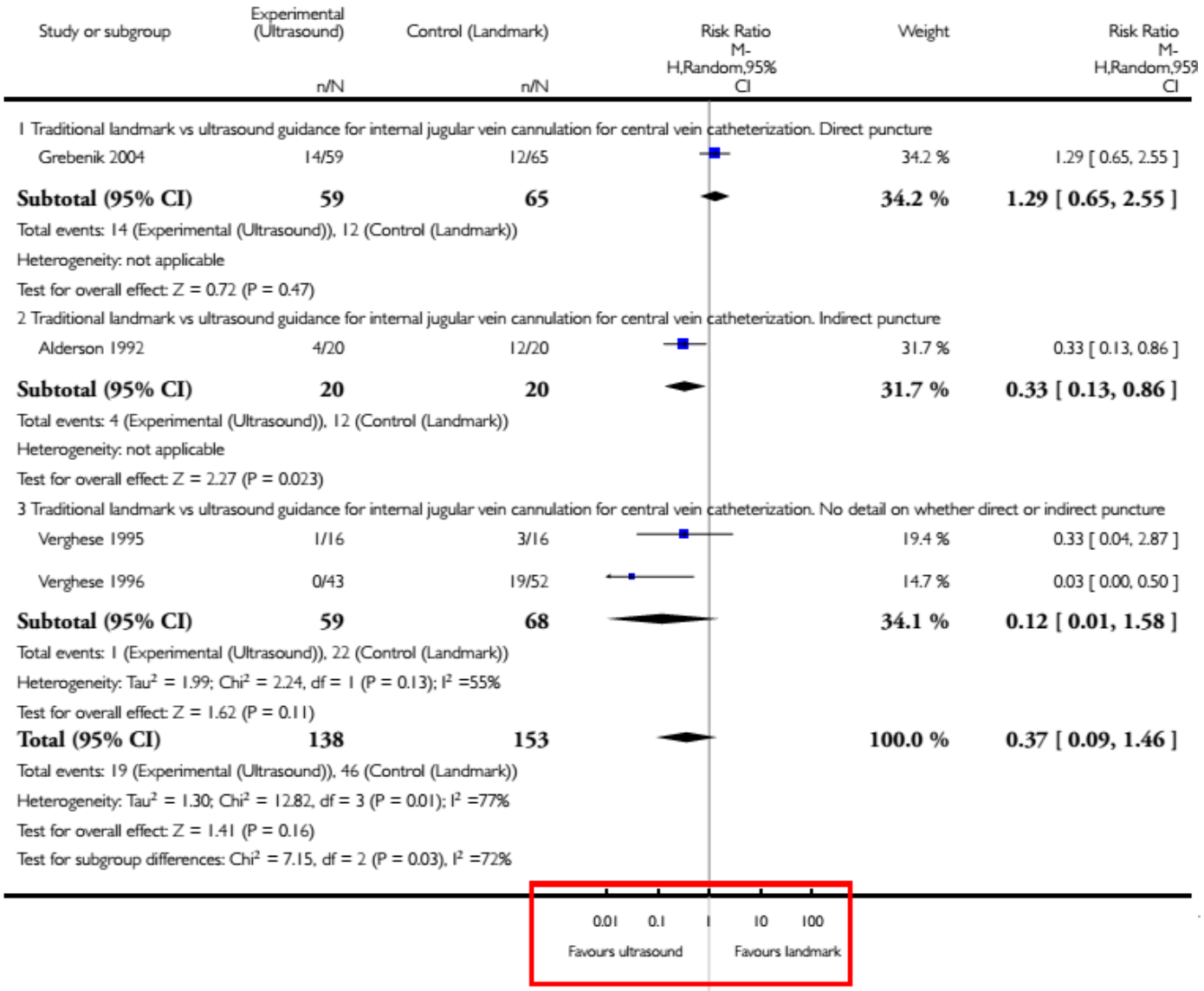
Number of attempts until success		Mean number of attempts until success in the intervention groups was **1.19 lower** (1.45 to 0.92 lower)		3302 (16 studies)	⊕◯◯◯ **Very low**[c,g,h,i]
Arterial puncture	**Study population**		**RR 0.28** (0.18 to 0.44)	4388 (22 studies)	⊕⊕◯◯ **Low**[c,j,k,l]
	94 per 1000	**26 per 1000** (17 to 41)			
	Moderate				
	84 per 1000	**24 per 1000** (15 to 37)			
Other complications (thrombosis, embolism, haematomediastinum and hydromediastinum, haematothorax and hydrothorax, pneumothorax, subcutaneous emphysema, nerve injury)	**Study population**		**RR 0.34** (0.15 to 0.76)	3042 (11 studies)	⊕⊕⊕◯ **Moderate**[c,m,n,o]
	30 per 1000	**10 per 1000** (4 to 23)			
	Moderate				
	23 per 1000	**8 per 1000** (3 to 17)			
Time to successful cannulation		Mean time to successful cannulation in the intervention groups was **30.52 lower** (55.21 to 5.82 lower)		3451 (20 studies)	⊕◯◯◯ **Very low**[l,p,q,r]
Success with attempt number 1	**Study population**		**RR 1.57** (1.36 to 1.82)	2681 (18 studies)	⊕⊕⊕◯ **Moderate**[c,s,t]
	501 per 1000	**787 per 1000** (682 to 912)			

Analysis 4.1. Comparison 4 Ultrasound guidance vs anatomical landmarks for internal jugular vein cannulation for central vein catheterization in children, Outcome 1 Complication rate total.

Review: Ultrasound guidance versus anatomical landmarks for internal jugular vein catheterization

Comparison: 4 Ultrasound guidance vs anatomical landmarks for internal jugular vein cannulation for central vein catheterization in children

Outcome: 1 Complication rate total



Analysis 4.2. Comparison 4 Ultrasound guidance vs anatomical landmarks for internal jugular vein cannulation for central vein catheterization in children, Outcome 2 Overall success rate.

Review: Ultrasound guidance versus anatomical landmarks for internal jugular vein catheterization

Comparison: 4 Ultrasound guidance vs anatomical landmarks for internal jugular vein cannulation for central vein catheterization in children

Outcome: 2 Overall success rate

Study or subgroup	Experimental (Ultrasound) n/N	Control (Landmark) n/N	Risk Ratio M-H,Random,95% CI	Weight	Risk Ratio M-H,Random,95% CI
1 Traditional landmark vs ultrasound guidance for internal jugular vein cannulation for central vein catheterization. Direct puncture					
Grebenik 2004	46/59	58/65		20.6 %	0.87 [0.74, 1.03]
Ovezov 2010	106/107	66/102		21.1 %	1.53 [1.33, 1.77]
Subtotal (95% CI)	**166**	**167**		**41.7 %**	**1.16 [0.66, 2.02]**
Total events: 152 (Experimental (Ultrasound)), 124 (Control (Landmark))					
Heterogeneity: $Tau^2 = 0.15$; $Chi^2 = 26.52$, df = 1 (P<0.00001); $I^2 = 96\%$					
Test for overall effect: Z = 0.52 (P = 0.60)					
2 Traditional landmark vs ultrasound guidance for internal jugular vein cannulation for central vein catheterization. Indirect puncture					
Alderson 1992	20/20	16/20		17.9 %	1.24 [0.98, 1.57]
Chuan 2005	32/32	24/30		19.6 %	1.25 [1.03, 1.50]
Subtotal (95% CI)	**52**	**50**		**37.5 %**	**1.24 [1.08, 1.44]**
Total events: 52 (Experimental (Ultrasound)), 40 (Control (Landmark))					
Heterogeneity: $Tau^2 = 0.0$; $Chi^2 = 0.00$, df = 1 (P = 0.98); $I^2 = 0.0\%$					
Test for overall effect: Z = 2.95 (P = 0.0032)					
3 Traditional landmark vs ultrasound guidance for internal jugular vein cannulation for central vein catheterization. No detail on whether direct or indirect puncture					
Verghese 1996	43/43	40/52		20.8 %	1.29 [1.11, 1.51]
Subtotal (95% CI)	**43**	**52**		**20.8 %**	**1.29 [1.11, 1.51]**
Total events: 43 (Experimental (Ultrasound)), 40 (Control (Landmark))					
Heterogeneity: not applicable					
Test for overall effect: Z = 3.30 (P = 0.00096)					
Total (95% CI)	**261**	**269**		**100.0 %**	**1.22 [1.00, 1.49]**
Total events: 247 (Experimental (Ultrasound)), 204 (Control (Landmark))					
Heterogeneity: $Tau^2 = 0.04$; $Chi^2 = 27.02$, df = 4 (P = 0.00002); $I^2 = 85\%$					
Test for overall effect: Z = 1.95 (P = 0.051)					
Test for subgroup differences: $Chi^2 = 0.23$, df = 2 (P = 0.89), $I^2 = 0.0\%$					

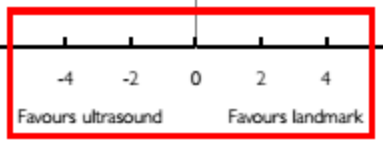
Analysis 4.3. Comparison 4 Ultrasound guidance vs anatomical landmarks for internal jugular vein cannulation for central vein catheterization in children, Outcome 3 Number of attempts until success.

Review: Ultrasound guidance versus anatomical landmarks for internal jugular vein catheterization

Comparison: 4 Ultrasound guidance vs anatomical landmarks for internal jugular vein cannulation for central vein catheterization in children

Outcome: 3 Number of attempts until success

Study or subgroup	Experimental (Ultrasound) N	Mean(SD)	Control (Landmark) N	Mean(SD)	Mean Difference IV,Random,95% CI	Weight	Mean Difference IV,Random,95% CI
1 Traditional landmark vs ultrasound guidance for internal jugular vein cannulation for central vein catheterization. Direct puncture							
Ovezov 2010	107	1.28 (0.07)	102	2.7 (0.17)		36.4 %	-1.42 [-1.46, -1.38]
Subtotal (95% CI)	**107**		**102**			**36.4 %**	**-1.42 [-1.46, -1.38]**
Heterogeneity: not applicable							
Test for overall effect: Z = 78.27 (P < 0.00001)							
2 Traditional landmark vs ultrasound guidance for internal jugular vein cannulation for central vein catheterization. Indirect puncture							
Alderson 1992	20	1.35 (0.67)	20	2 (0.97)		25.5 %	-0.65 [-1.17, -0.13]
Chuan 2005	32	1.57 (1.04)	30	2.55 (1.76)		19.7 %	-0.98 [-1.71, -0.25]
Subtotal (95% CI)	**52**		**50**			**45.3 %**	**-0.76 [-1.18, -0.34]**
Heterogeneity: $Tau^2 = 0.0$; $Chi^2 = 0.53$, df = 1 (P = 0.47); $I^2 = 0.0\%$							
Test for overall effect: Z = 3.54 (P = 0.00039)							
3 Traditional landmark vs ultrasound guidance for internal jugular vein cannulation for central vein catheterization. No detail on whether direct or indirect puncture							
Verghese 1996	43	1.3 (0.6)	52	3.3 (2.8)		18.4 %	-2.00 [-2.78, -1.22]
Subtotal (95% CI)	**43**		**52**			**18.4 %**	**-2.00 [-2.78, -1.22]**
Heterogeneity: not applicable							
Test for overall effect: Z = 5.01 (P < 0.00001)							
Total (95% CI)	**202**		**204**			**100.0 %**	**-1.24 [-1.72, -0.77]**
Heterogeneity: $Tau^2 = 0.16$; $Chi^2 = 12.02$, df = 3 (P = 0.01); $I^2 = 75\%$							
Test for overall effect: Z = 5.11 (P < 0.00001)							
Test for subgroup differences: $Chi^2 = 11.49$, df = 2 (P = 0.00), $I^2 = 83\%$							



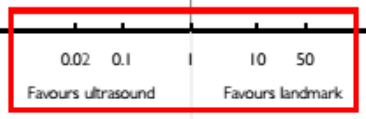
Analysis 4.4. Comparison 4 Ultrasound guidance vs anatomical landmarks for internal jugular vein cannulation for central vein catheterization in children, Outcome 4 Arterial puncture.

Review: Ultrasound guidance versus anatomical landmarks for internal jugular vein catheterization

Comparison: 4 Ultrasound guidance vs anatomical landmarks for internal jugular vein cannulation for central vein catheterization in children

Outcome: 4 Arterial puncture

Study or subgroup	Experimental (Ultrasound) n/N	Control (Landmark) n/N	Risk Ratio M-H,Random,95% CI	Weight	Risk Ratio M-H,Random,95% CI
1 Traditional landmark vs ultrasound guidance for internal jugular vein cannulation for central vein catheterization. Direct puncture					
Grebenik 2004	7/59	4/65		23.7 %	1.93 [0.59, 6.25]
Ovezov 2010	1/107	28/102		20.4 %	0.03 [0.00, 0.25]
Subtotal (95% CI)	**166**	**167**		**44.1 %**	**0.27 [0.00, 24.50]**
Total events: 8 (Experimental (Ultrasound)), 32 (Control (Landmark))					
Heterogeneity: Tau^2 = 9.85; Chi^2 = 15.31, df = 1 (P = 0.00009); I^2 =93%					
Test for overall effect: Z = 0.57 (P = 0.57)					
2 Traditional landmark vs ultrasound guidance for internal jugular vein cannulation for central vein catheterization. Indirect puncture					
Alderson 1992	1/20	2/20		18.9 %	0.50 [0.05, 5.08]
Chuan 2005	1/32	8/30		20.2 %	0.12 [0.02, 0.88]
Subtotal (95% CI)	**52**	**50**		**39.1 %**	**0.22 [0.05, 1.00]**
Total events: 2 (Experimental (Ultrasound)), 10 (Control (Landmark))					
Heterogeneity: Tau^2 = 0.0; Chi^2 = 0.88, df = 1 (P = 0.35); I^2 =0.0%					
Test for overall effect: Z = 1.96 (P = 0.051)					
3 Traditional landmark vs ultrasound guidance for internal jugular vein cannulation for central vein catheterization. No detail on whether direct or indirect puncture					
Verghese 1996	0/43	13/52		16.8 %	0.04 [0.00, 0.73]
Subtotal (95% CI)	**43**	**52**		**16.8 %**	**0.04 [0.00, 0.73]**
Total events: 0 (Experimental (Ultrasound)), 13 (Control (Landmark))					
Heterogeneity: not applicable					
Test for overall effect: Z = 2.18 (P = 0.029)					
Total (95% CI)	**261**	**269**		**100.0 %**	**0.20 [0.03, 1.35]**
Total events: 10 (Experimental (Ultrasound)), 55 (Control (Landmark))					
Heterogeneity: Tau^2 = 3.71; Chi^2 = 19.42, df = 4 (P = 0.00065); I^2 =79%					
Test for overall effect: Z = 1.65 (P = 0.099)					
Test for subgroup differences: Chi^2 = 1.02, df = 2 (P = 0.60), I^2 =0.0%					



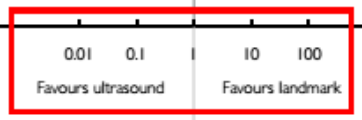
Analysis 4.5. Comparison 4 Ultrasound guidance vs anatomical landmarks for internal jugular vein cannulation for central vein catheterization in children, Outcome 5 Other complications (thrombosis, embolism, haematomediastinum and hydromediastinum, haematothorax and hydrothorax, pneumothorax, subcutaneous emphysema, nerve injury).

Review: Ultrasound guidance versus anatomical landmarks for internal jugular vein catheterization

Comparison: 4 Ultrasound guidance vs anatomical landmarks for internal jugular vein cannulation for central vein catheterization in children

Outcome: 5 Other complications (thrombosis, embolism, haematomediastinum and hydromediastinum, haematothorax and hydrothorax, pneumothorax, subcutaneous emphysema, nerve injury)

Study or subgroup	Experimental (Ultrasound) n/N	Control (Landmark) n/N	Risk Ratio M-H,Random,95% CI	Weight	Risk Ratio M-H,Random,95% CI
1 Traditional landmark vs ultrasound guidance for internal jugular vein cannulation for central vein catheterization. Direct puncture					
Grebenik 2004	0/59	4/65		12.3 %	0.12 [0.01, 2.22]
Subtotal (95% CI)	**59**	**65**		**12.3 %**	**0.12 [0.01, 2.22]**
Total events: 0 (Experimental (Ultrasound)), 4 (Control (Landmark))					
Heterogeneity: not applicable					
Test for overall effect: Z = 1.42 (P = 0.16)					
2 Traditional landmark vs ultrasound guidance for internal jugular vein cannulation for central vein catheterization. Indirect puncture					
Alderson 1992	3/20	8/20		75.0 %	0.38 [0.12, 1.21]
Subtotal (95% CI)	**20**	**20**		**75.0 %**	**0.38 [0.12, 1.21]**
Total events: 3 (Experimental (Ultrasound)), 8 (Control (Landmark))					
Heterogeneity: not applicable					
Test for overall effect: Z = 1.64 (P = 0.10)					
3 Traditional landmark vs ultrasound guidance for internal jugular vein cannulation for central vein catheterization. No detail on whether direct or indirect puncture					
Verghese 1996	0/43	6/52		12.7 %	0.09 [0.01, 1.60]
Subtotal (95% CI)	**43**	**52**		**12.7 %**	**0.09 [0.01, 1.60]**
Total events: 0 (Experimental (Ultrasound)), 6 (Control (Landmark))					
Heterogeneity: not applicable					
Test for overall effect: Z = 1.64 (P = 0.10)					
Total (95% CI)	**122**	**137**		**100.0 %**	**0.27 [0.10, 0.76]**
Total events: 3 (Experimental (Ultrasound)), 18 (Control (Landmark))					
Heterogeneity: $Tau^2 = 0.0$; $Chi^2 = 1.28$, df = 2 (P = 0.53); $I^2 = 0.0\%$					
Test for overall effect: Z = 2.50 (P = 0.012)					
Test for subgroup differences: $Chi^2 = 1.13$, df = 2 (P = 0.57), $I^2 = 0.0\%$					



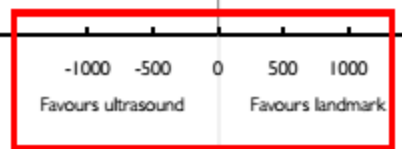
Analysis 4.6. Comparison 4 Ultrasound guidance vs anatomical landmarks for internal jugular vein cannulation for central vein catheterization in children, Outcome 6 Time to successful cannulation.

Review: Ultrasound guidance versus anatomical landmarks for internal jugular vein catheterization

Comparison: 4 Ultrasound guidance vs anatomical landmarks for internal jugular vein cannulation for central vein catheterization in children

Outcome: 6 Time to successful cannulation

Study or subgroup	Experimental (Ultrasound) N	Mean(SD)	Control (Landmark) N	Mean(SD)	Mean Difference IV,Random,95% CI	Weight	Mean Difference IV,Random,95% CI
1 Traditional landmark vs ultrasound guidance for internal jugular vein cannulation for central vein catheterization. Direct puncture. Time between penetration of skin and successful placement of guide wire within the internal jugular vein							
Grebenik 2004	59	97.8 (85.5)	65	92.4 (154.5)		36.4 %	5.40 [-38.04, 48.84]
Subtotal (95% CI)	**59**		**65**			**36.4 %**	**5.40 [-38.04, 48.84]**
Heterogeneity: not applicable							
Test for overall effect: Z = 0.24 (P = 0.81)							
2 Traditional landmark vs ultrasound guidance for internal jugular vein cannulation for central vein catheterization. Indirect puncture. Time taken to locate the vein							
Alderson 1992	20	23 (27.36)	20	56.38 (48.84)		38.4 %	-33.38 [-57.91, -8.85]
Subtotal (95% CI)	**20**		**20**			**38.4 %**	**-33.38 [-57.91, -8.85]**
Heterogeneity: not applicable							
Test for overall effect: Z = 2.67 (P = 0.0077)							
3 Traditional landmark vs ultrasound guidance for internal jugular vein cannulation for central vein catheterization. No detail on whether direct or indirect puncture. Time between insertion of needle into the skin until free flow of blood from the catheter							
Verghese 1995	16	271.2 (227.4)	16	399.6 (321)		14.8 %	-128.40 [-321.16, 64.36]
Verghese 1996	43	252 (168)	52	840 (906)		10.3 %	-588.00 [-839.32, -336.68]
Subtotal (95% CI)	**59**		**68**			**25.2 %**	**-350.84 [-801.00, 99.33]**
Heterogeneity: Tau^2 = 92559.25; Chi^2 = 8.09, df = 1 (P = 0.004); I^2 =88%							
Test for overall effect: Z = 1.53 (P = 0.13)							
Total (95% CI)	**138**		**153**			**100.0 %**	**-90.70 [-184.74, 3.35]**
Heterogeneity: Tau^2 = 5835.24; Chi^2 = 22.56, df = 3 (P = 0.00005); I^2 =87%							
Test for overall effect: Z = 1.89 (P = 0.059)							
Test for subgroup differences: Chi^2 = 4.34, df = 2 (P = 0.11), I^2 =54%							



Ultrasound-guided internal jugular vein catheterization in critically ill pediatric patients

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Purpose: Continuous intravenous access is imperative in emergency situations. Ultrasound-guided internal jugular vein (IJV) catheterization was investigated in critically ill pediatric patients to assess the feasibility of the procedure.

Methods: Patients admitted to the pediatric intensive care unit between February 2011 and September 2012 were enrolled in this study. All patients received a central venous catheter from attending house staff under ultrasound guidance. Outcome measures included successful insertion of the catheter, cannulation time, number of cannulation attempts, and number and type of resulting complications.

Results: Forty-one central venous catheters (93.2%) were successfully inserted into 44 patients (21 males and 23 females; mean age, 6.54±1.06 years). Thirty-three patients (75.0%) had neurological disorders. The right IJV was used for catheter insertion in 34 cases (82.9%). The mean number of cannulation attempts and the mean cannulation time was 1.57±0.34 and 14.07±1.91 minutes, respectively, the mean catheter dwell time was 14.73±2.5 days. Accidental catheter removal was observed in 9 patients (22.0%). Six patients (13.6%) reported complications, the most serious being catheter-related sepsis, which affected 1 patient (2.3%). Other complications included 2 reported cases of catheter malposition (4.6%), and 1 case each of arterial puncture (2.3%), pneumothorax (2.3%), and skin infection (2.3%).

Conclusion: The results suggest that ultrasound-guided IJV catheterization can be performed easily and without any serious complications in pediatric patients, even when performed by visiting house staff. Therefore, ultrasound-guided IJV catheterization is strongly recommended for critically ill pediatric patients.

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Ultrasound-guided internal jugular vein catheterization: a randomized controlled trial

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ABSTRACT

Introduction: Even though advantages of ultrasound line placement seem obvious, many countries do not have easy access to such technology. This study aims to compare the degree of difficulty in central venous line placement with or without ultrasound and the incidence of complications, and to establish the effect of the operator's degree of training.

Methods: The study included 257 patients that required central venous catheterization during the study period. Patients were divided into groups according to the operator's experience: expert group (over 70 central accesses performed before the study) (n = 152) and in-training or non-expert group. Procedures were randomized to "without ultrasound" (n = 80 expert and 54 non-expert) and "with ultrasound" (n = 72 expert and 51 non-expert).

Results: Catheter placements were more successful in the "expert" and in the "with ultrasound" than in the "non-expert" (88 % vs 79 %; p = 0.04) or in the "without ultrasound" groups (91 % vs 78 %; p = 0.005). Incidence of complications was 11.7 %, with no significant difference among "with ultrasound" (8.1 %) and "without ultrasound" (14.9 %) groups. However, the "non-expert" group had fewer complications with the use of ultrasound (7.8 % vs 24 %).

Conclusions: Ultrasound reduces the incidence of complications when placement is performed by inexperienced operators. Centers with residents should emphasize the necessity of ultrasound for central line catheterization. Training in ultrasound might be of paramount importance in the effectiveness of the technique.

Conlusions

- In summary, ultrasound - guided IJV catheterization:
  - Time jugular catheter placement has decreased significantly
  - Increase the success rate
  - Reducing incidence of complications.
- Ultrasound - guided IJV catheterization is strongly recommended for critically ill pediatric patients.

Thank you for your attention!